United States Department of Agriculture
Forest Service
Southwestern Region

Forest Pest Management Report

R-3 82-2

BIOLOGICAL EVALUATION
Western Spruce Budworm

Santa Fe National Forest
and Jemez Indian Pueblo
New Mexico

December 1981

3430

R-3 82-2

BIOLOGICAL EVALUATION
Western Spruce Budworm

Santa Fe National Forest
and Jemez Indian Pueblo
New Mexico

December 1981

Forest Pest Management
State and Private Forestry
Southwestern Region, USDA, Forest Service
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

PREPARED BY:

WILLIAM G. TELFER, Entomologist
Forest Pest Management

APPROVED BY:

DOUGLAS L. PARKER
Director of Forest Pest Management

ABSTRACT

Western spruce budworm, Choristoneura occidentalis Free., infestations increased forest-wide. Due to expanding infestations, the Jemez entomological units were realigned in 1981. A total of 125,085 acres of visible defoliation was recorded on the Santa Fe National Forest and adjoining lands in 1981. The State of New Mexico recorded 23,920 acres of visible defoliation on the Baca Location No. 1.

Average egg mass densities decreased in most areas sampled, but still remain at levels sufficient to cause moderate to heavy defoliation on the Jemez East and Jemez West entomological units. Although egg mass densities and acres of visible defoliation continued to increase on the Jemez Spray entomological unit, the average population still remains low. There was a significant increase in numbers of acres visibly defoliated on the new Jemez North entomological unit. Egg mass densities were extremely high on this unit and substantial increases in defoliation severity and area are expected in 1982.

Pest management alternatives and recommendations are discussed in this evaluation report.

INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Free., continued to cause defoliation in mixed conifer stands on the Santa Fe National Forest. Visible defoliation[1/] was first reported on the Jemez East and Jemez West entomological units in 1976 and on the Jemez Central entomological unit in 1977. In 1977, the Jemez West unit was aerially treated with carbaryl to suppress the budworm infestation.

Egg mass density surveys were conducted on all three entomological units, the Coyote Ranger District north of the San Pedro Parks Wilderness Area, and the Espanola Ranger District north of the Santa Clara Indian Reservation. Due to expanding infestations, the entomological units were realigned in 1981. Results are summarized in this evaluation, and management alternatives and recommendations are presented.

TECHNICAL INFORMATION

Insect.--Western spruce budworm, Choristoneura occidentalis Freeman

Hosts.--Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History.--The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

1/ Visible defoliation based on aerial detection surveys.

Stage	Time	Location on Host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June	On buds and strobile
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation.

1. Young larvae feeding on newly expanding buds and strobile.
2. Mature larvae consuming current year's needles.
3. Shoots webbed together by larvae.
4. Webbed shoots turning brown and falling from trees.
5. Defoliation most evident in upper crowns of trees.
6. Trees dying from the top downward after several years of heavy defoliation.

Extent of Defoliation in 1981.--Defoliation to host type was visible from the air on 125,085 acres of the Santa Fe National Forest and adjoining lands. Acres of defoliation by intensity class are: light, 32,335 acres; moderate, 79,750 acres; and heavy, 13,000 acres. Figures 1-5 show the extent and intensity of defoliation.

BIOLOGICAL INFORMATION

Relative Abundance of Pest

Methods.--Egg mass surveys were conducted in early August to provide an indication of larval populations and subsequent defoliation for 1982. Two branches (70 cm in length) were cut from opposite sides of the midcrown of three sample trees on plots located in all three entomological units, the Coyote Ranger District near the San Pedro Parks Wilderness Area, and the Espanola Ranger District north of the Santa Clara Indian Reservation. Sample trees met the following criteria: Douglas-fir, dominant or codominant; 30-50 feet in height; relatively open-grown with a full crown; and some budworm feeding evident, but not severely defoliated or top-killed. Each branch was individually bagged in cloth sacks, tied securely, labeled, and transported to a laboratory for examination. Foliage was stored in a walk-in cooler at about 40° F until examined.

In the laboratory, foliage was examined under ultraviolet light for egg masses. Needles with egg masses were classed as from current year's foliage or a previous year's foliage and kept separate in labeled boxes. New and old egg masses were separated by an experienced laboratory technician. All egg masses on current year's foliage were classed as new and their characteristics formed the basis for aging egg masses found on the previous year's foliage.

Defoliation estimates for 1982 were determined from the density of 1981 egg masses using the following information presented by McKnight et al, (1970):

Egg mass density[a/]	Predicted defoliation class[b/]
1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
34.10	Moderate for "static" infestations Heavy for "increasing" infestations

a/ Number of egg masses per square meter of foliage.
b/ Defoliation class limits (percent of new growth).
Undetectable = <5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = >65 percent

Results and Discussion.--Egg mass data show that, in general, larval densities will decrease in areas that have had several years of heavy defoliation, and will continue to increase in more recently defoliated areas. The extent of the infestation increased significantly on both the Forest and the Baca Location No. 1 this year, and some entomological unit boundaries on the Forest were no longer distinct; as a result, the unit boundaries have been adjusted (figure 1). Results of the egg mass surveys are discussed separately for each entomological unit below and are summarized in table 1.

Jemez East Entomological Unit. The boundaries of this unit remain the same as in previous years and consist of parts of the Jemez, Espanola, and Tesuque Ranger Districts (figure 1). Egg masses per square meter of foliage dropped from 58.3 in 1980 to 30.4 in 1981, while total acres defoliated increased from 44,075 to 57,700 (table 1). Defoliation extended from Los Griegos south to Tres Cerros east of Bandelier National Monument, and then north of Bandelier National Monument, to the Santa Clara Indian Reservation (figure 2). Defoliation also occurred on adjacent areas of the Baca Location No. 1. The majority of defoliated host type was categorized as moderate.

Although the buildup ratio of 1980 to 1981 egg masses decreased from 3.1:1 to 0.5:1, heavy defoliation is expected to continue in 1982. The infestation remains at epidemic population levels--30.4 egg masses per square meter of foliage. The cumulative effect of 3 consecutive years of defoliation will also increase the number of acres observed in the moderate and heavy defoliation classes by aerial detection survey next year. In 1982, moderate to heavy levels of defoliation are expected to continue from Los Griegos south to Tres Cerros and east to Bandelier National Monument, and east of the Baca Location No. 1 from American Springs to Santa Clara Creek in the Santa Clara Indian Reservation.

Jemez West Entomological Unit. This unit is a combination of the Jemez Central entomological unit and the Coyote Ranger District as described in the 1980 evaluation (Ragenovich 1980), and consists of parts of the Cuba, Jemez, and Coyote Ranger Districts (figure 1). These units (the Jemez Central entomological unit and the Coyote Ranger District) were combined because their infestations have grown together into one contiguous infestation. The data for 1980, shown in table 1, have also been combined for comparative purposes. Egg mass densities per square meter of foliage dropped from 44.2 to 21.4, while total acres defoliated increased from 18,865 to 51,410 (table 1). Defoliation was light to moderate from Ojitos Canyon north to the Rio Puerco, and in scattered locations from Coyote Creek east to Canones Creek. Moderate to heavy defoliation occurred from Cebollita Mesa north to Bear Canyon. The most severe defoliation on the unit occurred from the Rio Puerco northwest to the Rio Capulin, and then west-southwest to Upper La Jara (figure 3).

Although the egg mass buildup ratio of 1980:1981 is 0.5:1, the average egg mass density per square meter of foliage (21.4) indicates that defoliation in 1982 will continue at levels similar to those experienced in 1981. Heaviest defoliation will continue to occur around the San Pedro Mountains. Elsewhere, including the adjacent Baca Location No. 1, defoliation is expected to continue at light to moderate levels.

Jemez Spray Entomological Unit. This area was sprayed with carbaryl in 1977 (Parker et al. 1980), and as a result is considered separately from the Jemez West entomological unit. The unit consists of portions of the Cuba Ranger District and the Jemez Indian Pueblo (figure 1). Egg masses per square meter of foliage increased from 4.9 in 1980 to 6.1 in 1981, a buildup of 1.2:1, while total acreage defoliated increased from 5,960 in 1980 to 10,125 in 1981 (table 1). Moderate defoliation was detected from Bales Canyon to Trail Creek, and at the Clear Creek Campground (figure 4). A small pocket of heavy defoliation also occurred near the campground. Little or no visible defoliation has yet been detected on other portions of the spray area. Although the infestation on this unit is expected to increase in both area and intensity in 1982, it is still expected to remain at comparatively lower levels than untreated areas.

Jemez North Entomological Unit. This is a new entomological unit that consists of the western portion of the Espanola Ranger District (figure 1). It is located north of the Baca Location No. 1 and the Santa Clara Indian Reservation. Extensive budworm defoliation was detected and egg mass samples were collected for the first time in this area in 1981. Defoliation occurred on 5,850 acres (table 1). Defoliation occurred on Mesa del Ojito, Oso Canyon, Canoncito de los Ranchos, and northeast of Cienega Redonda (figure 5). The average egg mass density per square meter of foliage (51.3) indicates that the infestation will increase in both size and intensity in 1982. Similar increases are expected on adjacent areas of the Baca Location No. 1.

MANAGEMENT ALTERNATIVES

Maintain Present Management.--With this no action approach, the outbreak would be allowed to run its course until a population collapse occurred from a combination of: (a) a lack of foliage to maintain a larval population; (b) unfavorable weather conditions; (c) heavy predation and parasitism; and (d) a microbial epizootic. Adverse and beneficial effects of the outbreak would have to be accepted. These are:

1. This alternative would not be effective in preventing additional tree damages. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damages resulting from the western spruce budworm in the Southwest are currently unknown, maximum damages similar or higher than those estimated for the northern Rockies could occur if the outbreak continues unabated. These include the following:

Tree damages	Maximum damages (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree use reduction	90+

2. There would be no direct costs associated with selection of this alternative, although timber values will be affected and revenues reduced when severely damaged stands are harvested. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual qualities and economic and social impacts would result if this alternative was selected.

Silvicultural Management.--The main objective of this alternative is to promote effective timber management of the mixed conifer type. The pest management component of this alternative is to create stand conditions that reduce tree damages over the long-term. For example, prescriptions should: (a) open up stands by logging, thinning, and burning; (b) maintain stand densities favoring ponderosa pine and aspen; (c) favor prescribed burning to reduce the percentage of firs and Engelmann spruce; (d) regenerate stands by artificial means using ponderosa pine stock; (e) favor even-aged stands; and (f) salvage damaged and insect-killed trees.

Effects of this alternative are:

1. The trend of the current outbreak would not be changed if a silvicultural program were initiated. Tree damages would be the same as those listed under the "Maintain Present Management" alternative.

2. Visual qualities and economic and social impacts would result if this alternative were selected.

Direct Suppression.--Aerial application of a chemical pesticide registered by the U. S. Environmental Protection Agency (EPA) could be done to suppress the entire outbreak on the Forest or separate entomological units in 1982. However, if a treated area adjoins an area that is untreated, for instance, if the infestation on the Jemez West unit was treated and the adjoining San Pedro Parks Wilderness area was not, one or two additional treatments may be required since treated stands could be reinfested from the nearby untreated stands.

Application would be carefully timed to the development of the larvae, i.e., when 20 percent of the larvae are in the fifth and sixth instars. This would insure maximum effectiveness with a minimum dosage of insecticide. An application of this type is designed to utilize indigenous natural control agents to further reduce and maintain the budworm population at a low level.

Effects of this alternative are:

1. If a direct suppression program were to be carried out on the Forest in 1983, tree damages and losses occurring prior to treatment could not be prevented.

2. It would cost about $10.00 per acre to suppress the current outbreak. However, the permanent tree damages which occur during 1982 may determine whether or not it is economical to consider the direct suppression alternative.

3. Adverse environmental effects resulting from the aerial application of an insecticide would be minimal and temporary.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide)

The Sevin® 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe National Forest was successfully suppressed in 1977, and the outbreak has remained at a low level for 5 years (Parker and Ragenovich 1980). Carbaryl is a nonpersistent pesticide which is available for general use. One (1) pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene® (acephate) is a nonpersistent insecticide registered for use against the western spruce budworm and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad spectrum insecticide, registered for use against more than 100 insects, including the western spruce budworm. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

4. Microbial Insecticides

Microbial insecticides, such as Bacillus thuringiensis (B.t.), a bacterium, and viruses need further research testing and field evaluation before they are ready for use. In June 1981, two B.t. formulations were tested by USDA Forest Service and New Mexico Department of Agriculture near Eagle Nest, New Mexico. Preliminary results show that larval mortality was greater in sprayed areas than in check blocks; however, additional data analysis still needs to be done. B.t. could be used for treatment in sensitive areas, such as along stream courses, where a chemical pesticide would not be acceptable.

Treatment of High Value Trees.--In recreation areas, VIS Centers, and other areas where defoliation of high value trees would be unacceptable, individual or small groups of budworm-infested trees could be treated by a ground application of an EPA-registered insecticide to reduce the larval density and prevent the adverse effects of defoliation.

Effects of this alternative are:

1. Because only selected high value trees within an infestation could be treated, this would require yearly applications during the outbreak cycle, since treated trees would be reinfested from the nearby infested stands.

2. Application costs associated with this alternative would be relatively low and cost-effective.

3. Adverse environmental effects would be minimal and temporary.

RECOMMENDATIONS

1. Short-term Pest Management.--The infestation on the Jemez East entomological unit will begin to cause tree damages, in addition to growth loss, in the near future. To prevent these damages, direct suppression with an insecticide no later than 1983 is the recommended management alternative. After 1983, direct suppression may no longer be practical or economical. Also, to prevent the need for additional treatments due to reinvasion, direct suppression should be performed on adjacent infested stands on Bandelier National Monument and the Baca Location No. 1 in cooperation with the National Park Service and the State of New Mexico.

The infestations on the Jemez West entomological unit increased dramatically in both size and severity. Tree damages have not yet occurred, but

will begin in several years if the infestations continue at present levels. The recommended management alternative for 1982 is to maintain present management; however, if the infestation continues at the present level, the preferred option by 1983 may be direct suppression of the entire area, including the San Pedro Parks Wilderness Area and adjacent infested stands on the Baca Location No. 1. If these areas are not sprayed, several additional treatments may be necessary due to reinvasion from the untreated wilderness area.

Infestations in the Jemez Spray entomological unit are still at relatively low levels. The recommended management alternative for 1982 is to maintain present management.

Infestations on the Jemez North entomological unit are presently at very low levels. The recommended alternative for 1982 is to maintain present management. Direct suppression to prevent permanent damages may be recommended in several years.

2. Long-term Pest Management.--Long-term silvicultural management for western spruce budworm can be accomplished by including pest management considerations into timber and fire management programs. For example, management programs should facilitate the removal of susceptible old growth and favor ponderosa pine, Douglas-fir, and aspen in vigorous mixed conifer stands.

REFERENCES

Furniss, R. L., and V. M. Carolin. 1977. Western forest insects. USDA Forest Serv. Misc. Publ. No. 1339. 654 pp.

McKnight, M. E., J. F. Chansler, D. B. Cahill, and H. W. Flake, Jr. 1970. Sequential plan for western spruce budworm egg mass surveys in the central and southern Rocky Mountains. USDA Forest Serv. Res. Note RM-174. 5 pp.

Parker, D. L., R. E. Acciavatti, E. D. Lessard, and I. R. Ragenovich. 1980. Western spruce budworm suppression and evaluation project using carbaryl. USDA Forest Serv. Final Rep. R-3 80-2. 40 pp.

Parker, Douglas L., and Iral R. Ragenovich. 1980. Western spruce budworm suppression and evaluation project using carbaryl, 1979. USDA Forest Serv. Progress Rep. No. 3. R-3 80-1. 56 pp.

Ragenovich, I. R. 1980. Biological evaluation. Western spruce budworm, Santa Fe National Forest and Jemez Indian Pueblo. USDA Forest Serv. Region 3. R-3 81-5.

A P P E N D I X

Table 1.--Summary of egg mass density and aerial detection survey on the Jemez East, West, Spray, and North entomological units, Santa Fe National Forest, 1981.

		JEMEZ EAST ENTOMOLOGICAL UNIT					
		1976	1977	1978	1979	1980	1981
New egg masses/ sq. meter foliage		16.9	12.7	12.1	18.9	58.3	30.4
Buildup ratio		---	0.7:1	0.9:1	1.6:1	3.1:1	0.5:1
Actual defoliation (acres)	L	2,520	56,872	3,309	1,638	22,880	15,200
	M	2,440	1,556	503	512	18,635	39,200
	H	0	0	0	0	2,560	3,300
	TOTAL	4,960	58,428	3,812	2,150	44,075	57,700

		JEMEZ WEST ENTOMOLOGICAL UNIT[1/]					
		1976	1977	1978	1979	1980	1981
New egg masses/ sq. meter foliage		---	4.3	6.1	9.7	44.2	21.4
Buildup ratio		---	---	1.4:1	1.6:1	---	0.5:1
Actual defoliation (acres)	L	0	435	512	716	7,370	12,810
	M	0	589	418	0	7,885	30,000
	H	0	0	0	0	3,610	8,600
	TOTAL	0	1,024	930	716	18,865	51,410

		JEMEZ SPRAY ENTOMOLOGICAL UNIT					
		1976	1977	1978	1979	1980	1981
Egg masses/sq. meter foliage		12.6	1.7	0.5	0.6	4.9	6.1
Buildup ratio		---	0.1:1	0.3:1	1.2:1	8.2:1	1.2:1
Actual defoliation (acres)	L	8,400	1,894	0	486	4,500	1,025
	M	3,800	218	0	563	1,460	8,775
	H	240	0	0	0	0	325
	TOTAL	12,440	2,112	0	1,049	5,960	10,125

1/ Previously the Jemez Central entomological unit, 1976-1980, and the Coyote Ranger District which was separate in 1980. These were combined in 1981 due to infestation growth and were recalculated for 1980 for comparison purposes.

Table 1 (cont'd.)

JEMEZ NORTH ENTOMOLOGICAL UNIT 2/		
		1981
Egg masses/sq. meter foliage		51.3
Buildup ratio		---
Actual defoliation (acres)	L	3,300
	M	1,775
	H	775
	TOTAL	5,850

2/ This is a new entomological unit, see figure 5.

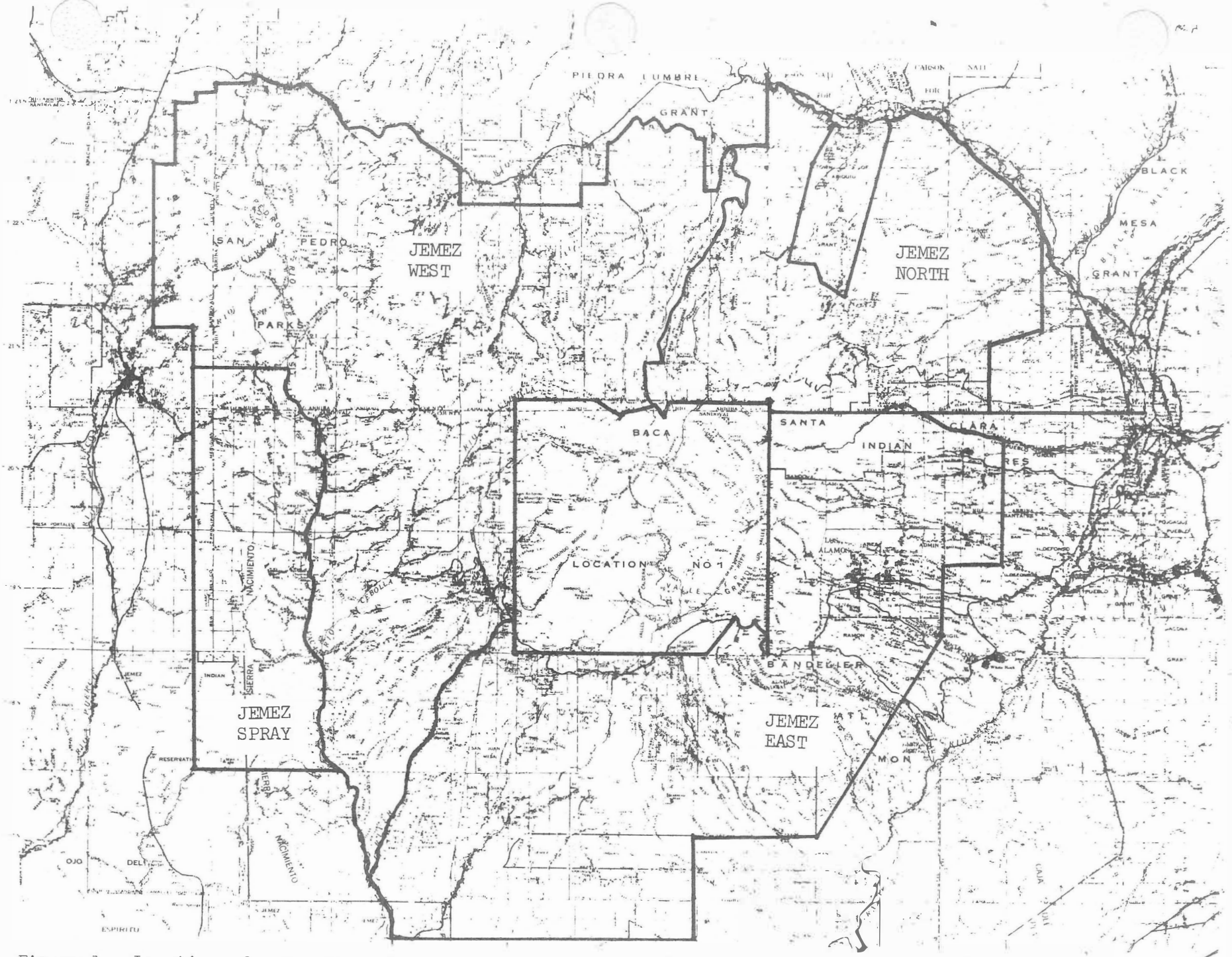


Figure 1.--Location of entomological units on the west half, Santa Fe National Forest, 1981.

Figure 2.--Western spruce budworm defoliation, Jemez East entomological unit, Santa Fe National Forest, 1981.

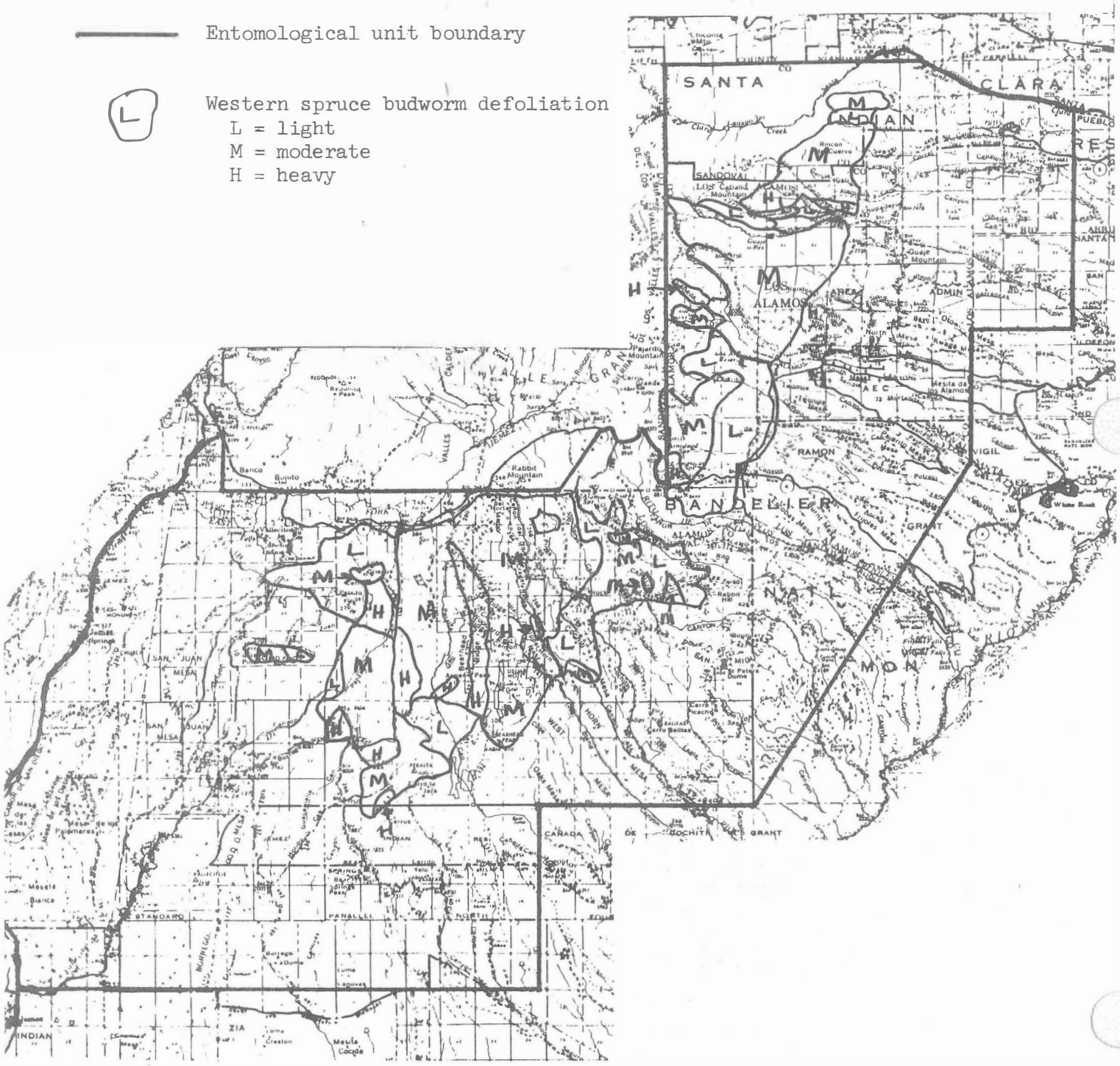


Figure 3.--Western spruce budworm defoliation, Jemez West entomological unit, Santa Fe National Forest, 1981.

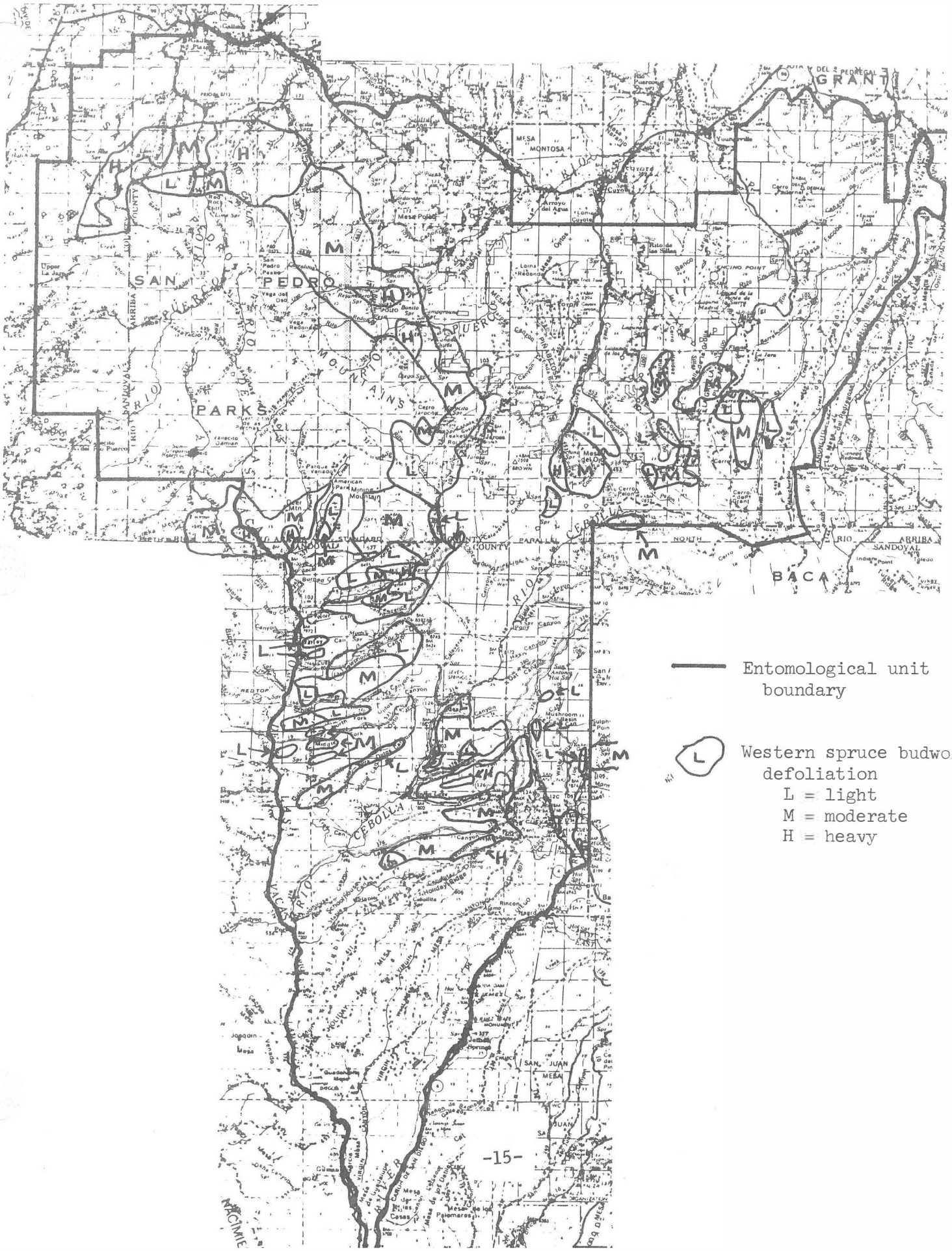
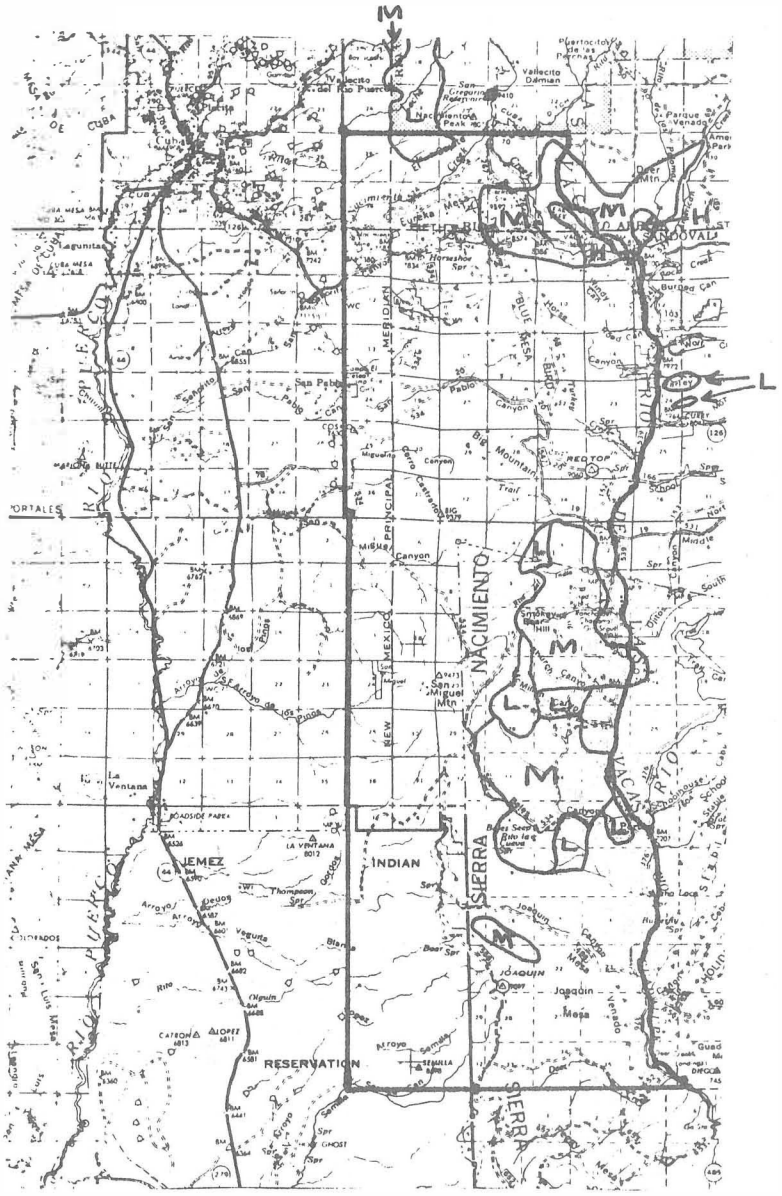


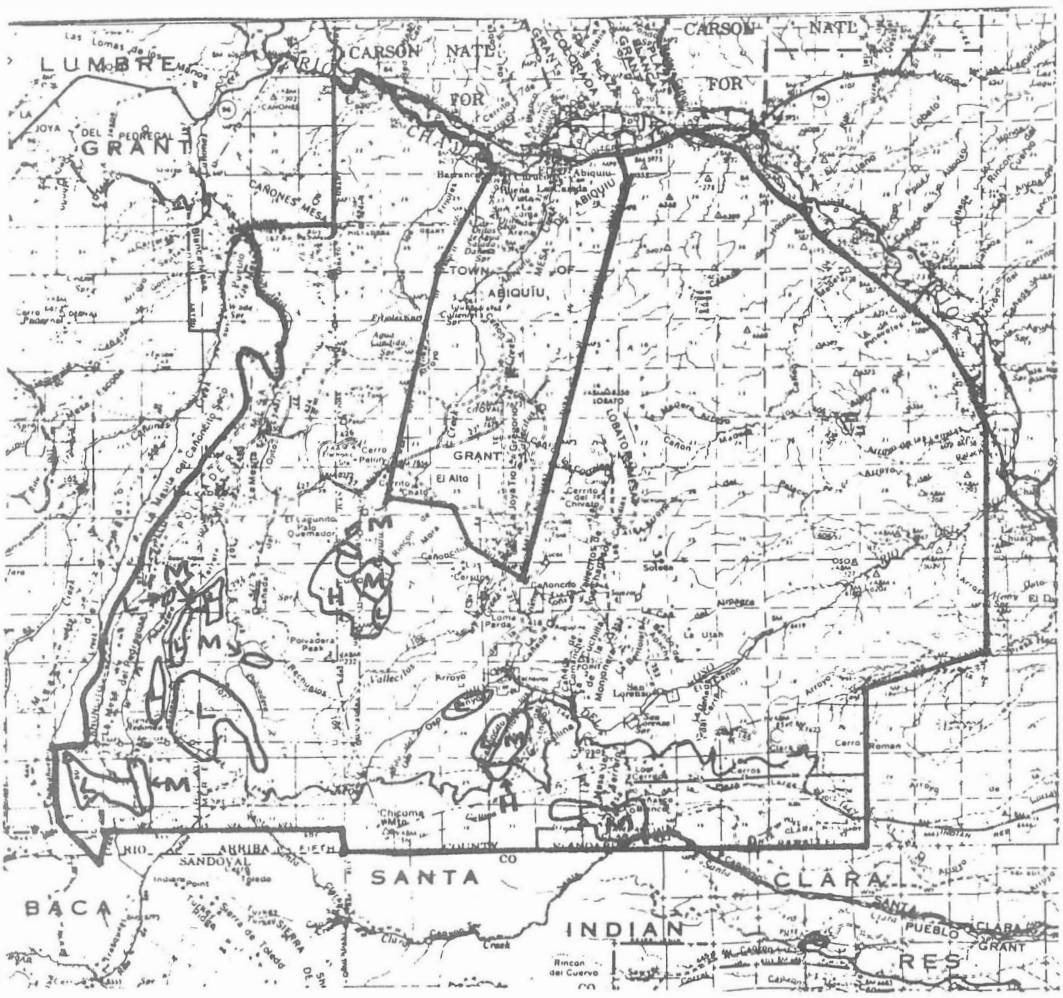
Figure 4.--Western spruce budworm, Jemez Spray entomological unit, Santa Fe National Forest, 1981.



Entomological unit boundary

Western spruce budworm defoliation
- L = light
- M = moderate
- H = heavy

Figure 5.--Western spruce budworm defoliation, Jemez North entomological unit, Santa Fe National Forest, 1981.



Entomological unit boundary

Western spruce budworm defoliation
L = light
M = moderate
H = heavy